TITLE: THE THERMOREGULATORY THRESHOLD IN HUMANS DURING NITROUS OXIDE/FENTANYL ANESTHESIA

Authors: D.I. Sessler, M.D., C.I. Olofsson, M.D., and E.H. Rubinstein, M.D., Ph.D.†

Affiliation: Department of Anesthesia, UCSF, 94143, and †Departments of Anesthesiology and Physiology, UCLA 90024

Introduction. Hypothermia produces thermoregulatory vasoconstriction in patients anesthetized with halothane[1] and isoflurane,[2] but the response thresholds are ≈ 2.5°C below normal. Both narcotics and N_2O inhibit thermoregulatory responses in animals.[3,4] We tested the hypothesis that N_2O/fentanyl anesthesia would decrease the thermoregulatory threshold in humans. We also compared the decrease in cutaneous capillary (nutritional) blood flow to the decrease in arterio-venous shunt (thermoregulatory) flow.

Methods. With approval from our Committee on Human Research, we studied 15 unpremedicated patients electively donating a kidney. Anesthesia was induced with halothane/N_2O and maintained with N_2O (70%), vecuronium, and fentanyl (a loading dose of 10 mcg/kg followed by an infusion of 4 mcg·kg^{-1}·h^{-1}). Patients were randomly assigned to receive no hypothermia precautions (n = 10) or additional warming measures including warm intravenous fluids and breathing circuit humidification (n = 5).

Constriction of thermoregulatory *arterio-venous shunts* was evaluated using skin-temperature gradients (fingertip surface temperature subtracted from forearm surface temperature). Significant vasoconstriction was prospectively defined as a skin temperature gradient ≥ 4°C[1] and the thermoregulatory threshold was defined as the esophageal temperature at which vasoconstriction occurred. Peripheral *capillary* vasoconstriction was evaluated using a Periflux® 3 laser Doppler monitor which correlates well with ^{133}Xe washout[5] and dynamic capillaroscopy.[6]

Results. The five patients actively warmed remained nearly-normothermic with a mean lowest esophageal temperature of 35.8 ± 0.4°C. Skin-surface temperature gradients were < 1°C in all actively warmed patients, and became ≥ 4°C in 6 of 10 hypothermic patients ($P < 0.05$) between 100 and 190 min following induction. The thermoregulatory threshold in the six hypothermic patients who vasoconstricted was 34.2 ± 0.5°C (SD) (fig. 1). The perfusion index and the skin-temperature gradient were correlated (regression equation: **Perfusion index = -7.9 * Gradient + 67**; $r^2 = 0.63$) (fig. 2).

Discussion. The thermoregulatory threshold during N_2O/fentanyl anesthesia, 34.2 ± 0.2°C, was similar to that during halothane/oxygen, 34.4 ± 0.2°C.[1] Vasoconstriction did not occur in four of 10 hypothermic patients given N_2O/fentanyl, but did in all hypothermic patients given halothane.[1] These four hypothermic patients probably reached a passive thermal steady state (constant core temperature without vasoconstriction). Total digital skin blood flow is divided into arterio-venous shunt (thermoregulatory) and capillary (nutritional) components.[7,8] Thermoregulatory vasoconstriction is thought to occur primarily in the cutaneous arterio-venous shunts,[9] but we found that capillary flow also decreased significantly.

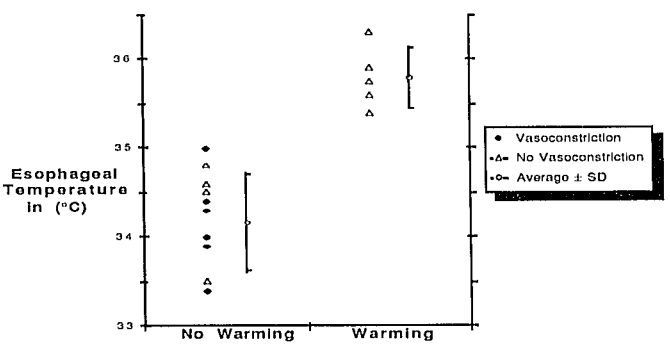

Figure 1. Significant vasoconstriction was observed in 6 of 10 elective kidney donors who became hypothermic (left side of figure). Vasoconstriction did not occur in 5 other patients maintained normothermic (right side of figure).

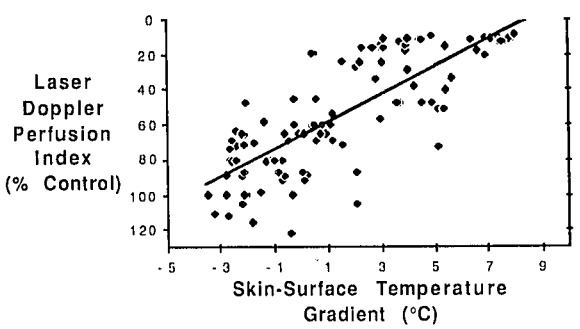

Figure 2. Skin-surface temperature gradient is plotted against the laser Doppler perfusion index (% control).

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